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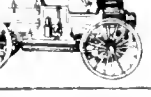
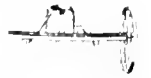
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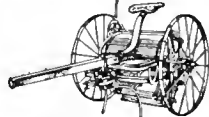
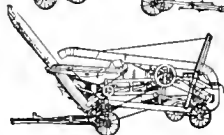
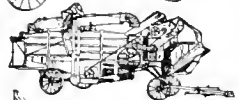
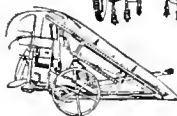
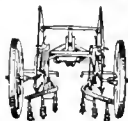
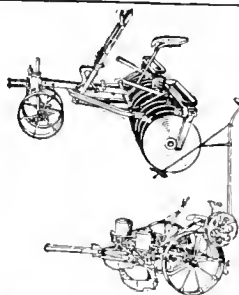
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CHICAGO U S A

MECHANICAL IRRIGATION





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STACKERS
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COMBINED SWEEP RAKES
AND STACKERS

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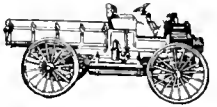
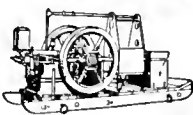
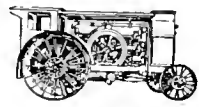
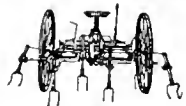
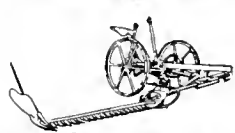
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PEG-TOOTH HARROWS
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MECHANICAL IRRIGATION



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MECHANICAL IRRIGATION

Principles of Irrigation

The art of mechanical irrigation is as old as civilization, and dates back to the earliest records of man. From the first, the difficulty has been the labor involved in raising water in sufficient quantities. Many crude but ingenious devices were employed by the ancients, some of which are still used in some parts of the world. It is only within recent years that the attention of engineers has been directed toward devising a means of raising water that is inexpensive enough in operating cost and yet possesses sufficient capacity to be practical. Many kinds of power have been used with success, but foremost among these stands the gasoline and kerosene engine. The economy, ease of operation, and reliability of this engine have solved the power problem not only for irrigation but for many other kinds of farm work connected with the growing, harvesting, and marketing of farm crops.

Farming by irrigation requires different methods than farming where there is abundant rainfall, and it succeeds best by scientific, or what is known as intensive, farming. The soil should be carefully prepared and kept thoroughly cultivated. Crops should be selected which give the largest returns per acre. Among the crops that have been most successful under irrigation are fruits, alfalfa, rice, vineyards, garden produce (especially asparagus, celery, and strawberries), potatoes, hops, tobacco, and cotton.



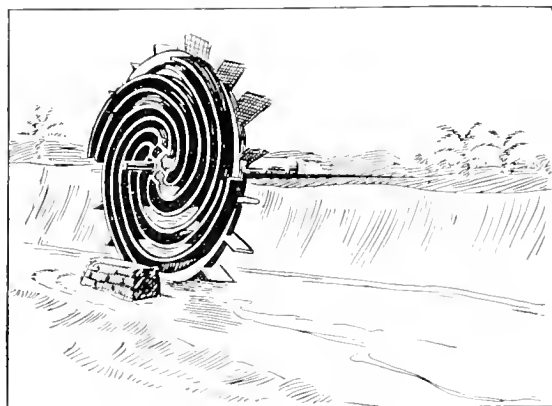
Old Egyptian method of irrigating

Some of the advantages of irrigation are as follows: Submergence improves the land by depositing silt and new soil; multiplies the productive capacity of soil; destroys insects and worms; makes

the farmer independent of rainfall; prolongs the harvest period of various crops if so desired; insures two or more crops annually in the lower latitudes; makes farming profitable in waste places, and enables man to reclaim apparently worthless land.

Government experiments have proved, beyond all question, that in localities where there is insufficient rainfall, the addition of water, by irrigation, in the right quantities at the proper time, will often increase the crop yield from two to threefold, while too much water will decrease the yield again.

The reason for this is plain when it is understood what relation water bears to the soil and plant life. The soil contains such substances as



Old Grecian method of irrigating

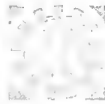
carbon, potassium, phosphorus, nitrogen, etc., which are plant foods, and essential to plant growth. Water, in seeping through the soil, dissolves compounds of these plant foods and is absorbed by the plant roots. Air is also necessary to plants, and when too much water is applied it saturates the soil to such an extent that air is excluded, retarding their growth.

Some soils absorb more water than others; some retain water longer than others, therefore, when irrigating, the kind of soil must be taken into consideration. Soils may be classed as sand, clay, loam, marl, lime, salt, peat, or muck. Those most commonly in irrigated sections are as follows:

Sand—Sand constitutes from 8 to 90 per cent or more of most soils. It is nearly pure quartz and contains little plant food. It is easy to work,

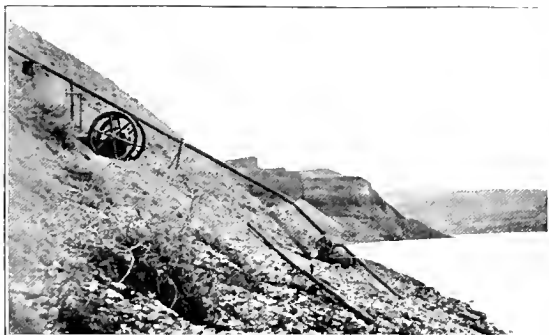


MECHANICAL IRRIGATION



does not bake, and absorbs but little moisture. Therefore, soils rich in sand require more water.

Clay — Clay is a compound of silicon and aluminum, and also contains potash, lime, nitrogen, phosphorus, etc., which are elements valuable to



Modern IHC method of irrigating

plant life. It forms 10 to 90 per cent of nearly all soils. It is hard to work and apt to bake, but holds moisture well, therefore needs less irrigating.

Loam — Loam soils are rich in alkali and potash, and contain but little sand. They are medium, between sand and clay, and are the most desirable of all soils for irrigating, as they require a relatively small amount of water.

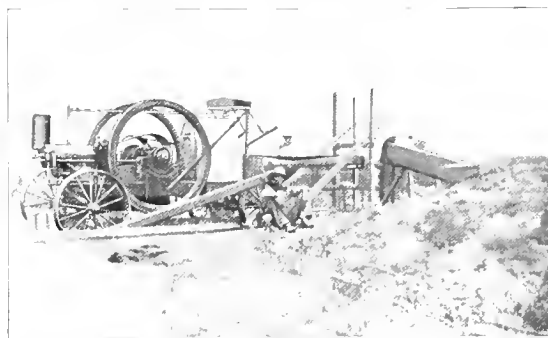
In irrigating, the aim is not to drown the soil but to obtain about a 70 per cent saturation.

The average amount of water used is twenty-one acre-inches in a period of 100 days — about five

A simple way for determining the presence of moisture in the soil, is to take out a handful from a few inches below the surface and squeeze it. If it balls in the hand, irrigation is not needed at that time.

When irrigating light soils, very small streams of water should be used, otherwise, there is danger of washing the plant food out of the soil. After irrigating it is important to keep the soil thoroughly cultivated. Scientists agree that the soil is full of capillary tubes, through which moisture finds its way to the surface and evaporates. To conserve the water in the soil, these tubes must be kept closed by surface cultivation. Cultivated soil is like a blanket — it prevents loss of moisture, and protects against the hot rays of the sun.

On many irrigated farms alkali is present, and a few words in regard to its treatment will not be amiss. Alkali is found in different forms, of which the principal bases are soda, potash, and ammonia



IHC Titan 12-H. P. Engine operating No. 6 pump — Plant of Wm. Jones, near Greeley — 12-foot vertical lift

in varying proportions. Alkali is necessary to plant growth but when in too large quantities is very injurious. Too much alkali can often be remedied by cultivation and frequent irrigation by the flooding system with good drainage. Another method is to underlay the land with unglazed vitrified sewer pipe. The growth of leguminous crops is also beneficial.

The questions naturally arise — How much water is needed and at what time should it be applied? The answer to these questions depend entirely on local conditions, which have to be ascertained before reliable information can be given. The amount of rainfall, the crops, suitable to the local soil and climate, the amount of water necessary, and the best time to apply it to get a maximum crop should be ascertained from the state department of agriculture.



IHC 4-H. P. irrigating plant near Pierce, Colo., 8-foot lift, capacity 600 gallons per minute. This plant paid for itself the first season

acre-inches at a single irrigation. While this would do for one district, so much depends upon local condition, and the crop to be grown, that it might be either too much or too little for others.

MECHANICAL IRRIGATION

The difference between the annual rainfall, and the amount of water required to give a maximum crop, is usually the amount which must be supplied by irrigation.

The lay of the land, the condition of the soil, and the crop to be raised determine the method of irrigating. Some plants require a large amount of water at one time; others, a small amount all the time; still others, water at different times; so it is evident that one method will not answer for all conditions. Four methods are in common use:—

Flowing—The water is run over the land through small ditches or furrows from a general head ditch or lateral. The smaller furrows are run at right



Flowing method of irrigation

angles through the ground to be irrigated. This method is generally used to irrigate gardens and orchards. It is always best to cultivate as soon after irrigating as possible in order to prevent loss of moisture by evaporation. Water should not be allowed to run through the furrows too rapidly as the fertility is washed from the soil near the entrance of the water and deposited further down.

The fine deposits also act like a cement on the bottom of the furrow and prevent the water from sinking into the soil.

Flooding—Flooding requires less labor and is considered the quickest and cheapest method of irrigating. The land should be as level as possible in order to avoid the formation of stagnant pools.

Standing water cuts off the air from plant roots and retards their growth. Hay and grain crops are commonly irrigated by this method. For the hot, dry season, where there is no danger of over-saturating the soil, the depressed bed is adaptable for all kinds of vegetables, small fruits, and flowers. The land is laid out in rectangular checks,



Flooding method of irrigation

the sides of which form elevated ditches which carry the water.

Seepage—This method is used to economize water. It is accomplished by running the water through underground pipes or conduits to the highest point in each plot, containing up to about 10 acres, where it is delivered into a flume extending entirely across the plot. Furrows are plowed down from this flume, and the water is admitted into them in small quantities and allowed to seep into the soil. Cultivation must follow immediately, in order to retain the moisture in the soil. In some cases the land is undermined with porous pipes from which the water seeps into the surrounding soil. Deep ditches are also used to serve the same purpose.



Seepage method of irrigation

Sprinkling—There is no better form of irrigation than sprinkling. It is used mainly in Florida for irrigating orange land, and is also adapted for garden culture. Water is piped over the land and hydrants placed at intervals.



MECHANICAL IRRIGATION



It is somewhat more expensive than the simpler methods and requires more soil cultivation, as the water cannot be put on in large quantities and must be conserved.



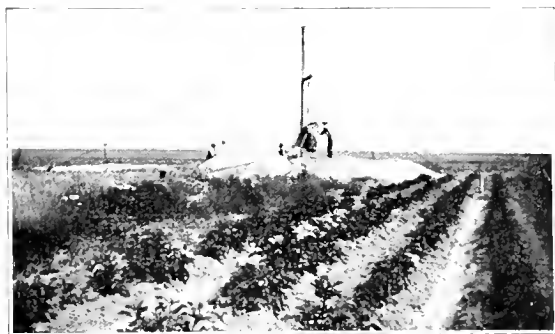
Sprinkling method of irrigating

Sources of Water Supply

After determining the quantity of water required and the method of distributing, the next and most important step is to determine how it is to be obtained. When water is at hand and can be run on to the land by gravity, no further advice is needed. The aim of this booklet is to offer aid and suggestions to those requiring mechanical means of obtaining water. Power in some form has to be provided, and it is here that the success or failure of mechanical irrigation most often lies.

Pumping from Lakes, Rivers, and Streams

It is always desirable to locate the pump as near the supply of water as possible, and the vertical lift from the water to the pump should not, in any case, be over 20 feet.



Digging an irrigation well near Pierce, Colo.

Where a lake, river, or stream is available, a centrifugal pump may be used if the suction lift and head is not too great. This type of pump has the advantage of delivering a large volume of water for the amount of power required.

It is also the most desirable method of pumping as there are no valves. It will handle muddy water without trouble. It works most efficiently when the total lift is not over 50 feet, the suction lift being under 20 feet, and pump partially submerged if possible. For high lifts, 2 and 3 stage centrifugal pumps are manufactured.

Pumping from Wells

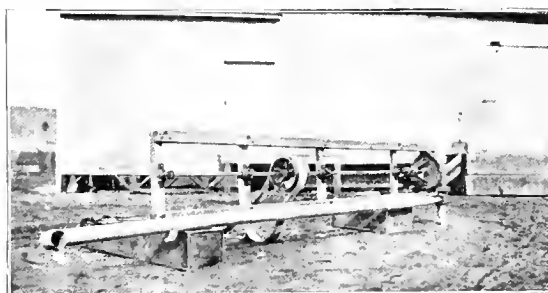
Wells used for irrigation are of two general types—dug wells and driven wells. Sometimes a



Concrete curbed irrigation well

combination of the two is used. When dug wells are used, centrifugal pumps may be installed, but for driven or drilled wells, a deep well cylinder pump should be used.

Before installing a well pumping plant, it is always necessary to ascertain the lowest level at which the water will hold in the well when being pumped. If there is a similar plant in the neighborhood, it is reasonable to assume conditions will be the same. When possible, an experimental plant should be installed, otherwise the lowest level must be estimated.



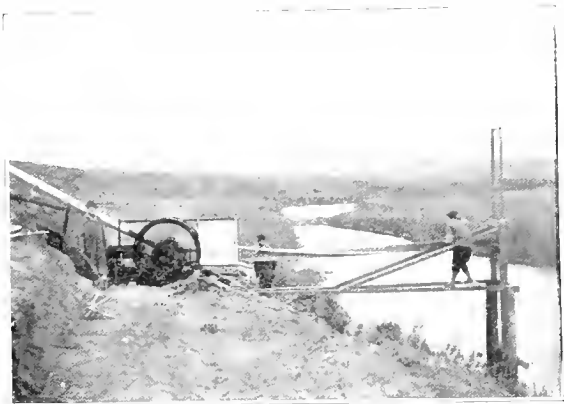
Method of framing vertical centrifugal pump

MECHANICAL IRRIGATION

Power for Irrigation Pumping

Where the gravity system cannot be used, mechanical means must be employed to raise the water to a sufficient height to insure its proper distribution.

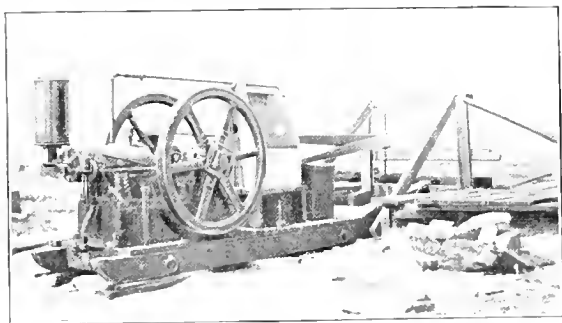
In order to secure a profit to the farmer, the



Irrigating outfit of Fred Halsey—Sharon Springs, Kansas

cost of irrigating must be considerably less than the benefits derived. Therefore, in selecting a power, the cost of operation, reliability, ease of operation, convenience, and ability to get fuel without loss of time or too much labor should be considered.

I H C oil engines have proved the most success-



I H C 8-H. P. Titan Horizontal Engine operating centrifugal pump against a 55-ft. head near Falcon, Colo.

ful, economical, and reliable under practically all conditions. They are a safe selection, because their efficiency under similar conditions has been proved. I H C engines give the most power on the least fuel, and can be equipped to operate on gas, gasoline, kerosene, distillate, solar oil, gas oil or motor spirit, thereby enabling you to take



I H C Titan Portable Engine irrigating near Crawford, Neb.

advantage of the least expensive fuel in your locality.

Then the ease of hauling and handling the small amount of fuel required is a great advantage. Think of the work necessary to haul wood or coal enough for a steam plant.

The ease of operating I H C engines is another point in their favor. Practically the only atten-



I H C Mogul kerosene engine and side suction centrifugal pump

tion they need, after starting, is to see that they are properly lubricated about every two hours.

Often it is necessary to move the power about or install it on a river bank, and here again I H C engines are the most practical power. They weigh less and are more compact than any other form of power, and are made in stationary, semi-portable, portable, and traction types.

Besides pumping water for irrigating, an I H C engine can be used for other work on the farm, and will more than pay for itself for this use alone. The reliability of I H C engines is attested by thousands of users. Their simple, strong construction guarantees you long, efficient service.

Another point that should not be overlooked is I H C service. I H C dealers are located in nearly every community, and the owner of an I H C

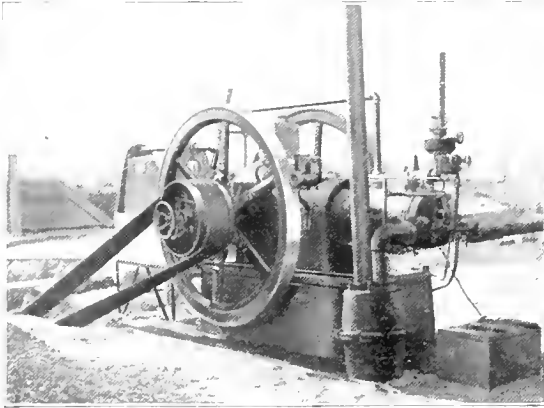
MECHANICAL IRRIGATION

engine is given all the assistance possible. Repair stocks are conveniently located, so that it is a simple matter to obtain repairs for any I H C machine on short notice.

In designing an irrigation pumping plant, conditions are often such that to install steam or



I H C Titan 4-H. P. engine owned by Mr. Jackson, Pierce, Colo., operating No. 4 pump—8-foot lift—about 600 gallons per minute



I H C Mogul 20-H. P. kerosene engine installed at Scott City, Kansas, operating plant of H. J. Mott

electricity, the pumping outfit must be designed to suit the power, which would entail an unnecessary additional expense. When I H C engines are used for irrigation power, no matter what the pumping installation problem is, there is an I H C engine of special size and design which will meet your conditions to the best advantage with out altering the pumping system.

You can design the pumping system to suit the local conditions, then select the I H C engine best suited to the purpose. This is especially true where there are several wells located in different parts of the farm. If electricity were used, several motors would be required and an expensive system of wiring, while if steam were employed you would have a heavy, cumbersome outfit, for which a large quantity of coal or wood would have to be hauled at great expense and trouble,

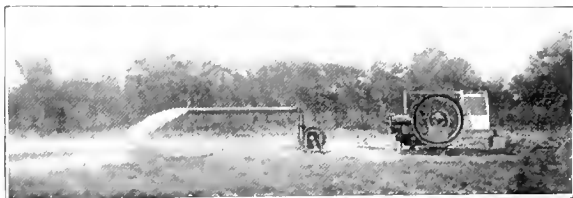
and two or three men and a team would be required to operate the plant.

A light portable I H C engine can be hauled to any part of the farm over the roughest roads with little trouble, and the only attention it would

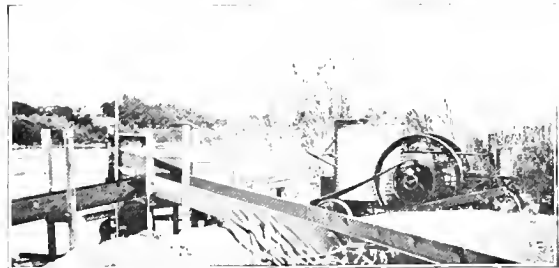


The kind of stream an I H C engine pumps

need after starting, is to see that the bearings are properly oiled every two or three hours. Where only a small pumping outfit is required, an I H C engine will give better economy for the amount of water pumped than any other form of power, and requires so little attention after starting that one man can operate the engine and attend to the irrigating water at the same time.



I H C Titan horizontal engine and side suction centrifugal pump



I H C Titan 15-H. P. portable engine irrigating with a No. 8 centrifugal pump near Cascade, Mont.

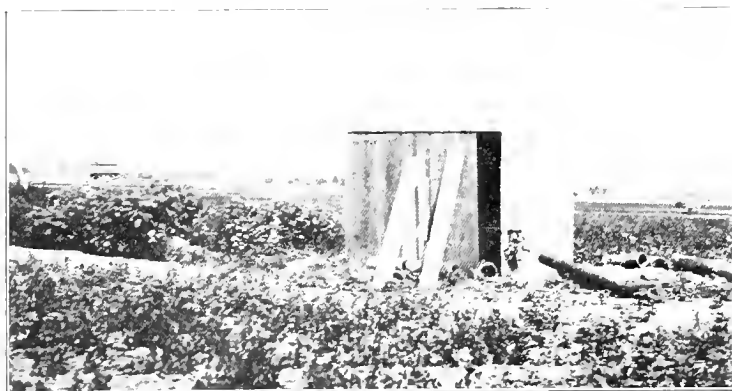
MECHANICAL IRRIGATION

An Irrigated Sugar Beet Farm

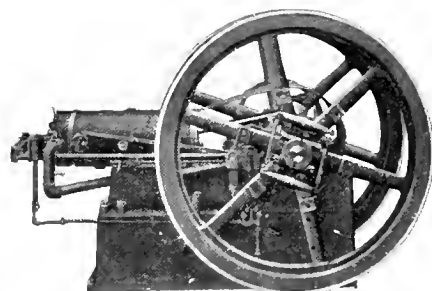
This 20-acre farm at Longmont, Colo., is successfully using an independent I H C irrigating plant to irrigate 13 acres of peas and sugar beets. The power plant consists of a 6-H. P. I H C engine and a No. 4 centrifugal pump, pumping from a well against a head of ten and one-half feet through eight-inch iron distributing pipes. This is a good method of distributing water in many localities as it prevents evaporation and seepage before the water reaches the ground to be irrigated. This is typical of the small I H C irrigating outfits that have been so successful throughout the country.



The home



The power house



The engine used—an I H C 6-H. P. Titan stationary engine



The sugar-beet field. Photo taken in early July

MECHANICAL IRRIGATION

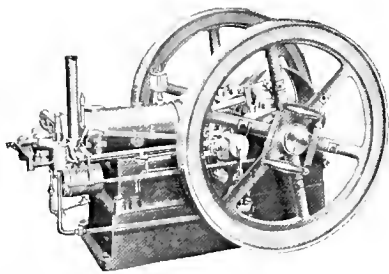
An Irrigated Stock Farm

Garden City, Kans., has its share of I H C irrigated farms. The illustrations show one of the newest in this vicinity consisting of 120 acres, 28 acres being under irrigation at present, principally alfalfa for stock and corn. The power is a 15-H. P. I H C oil engine and No. 5 centrifugal pump, pumping from a well 44 feet deep against a total head of 24 feet, delivering 900 gallons per minute. The water is pumped into a reservoir and from there into the ditches as needed.

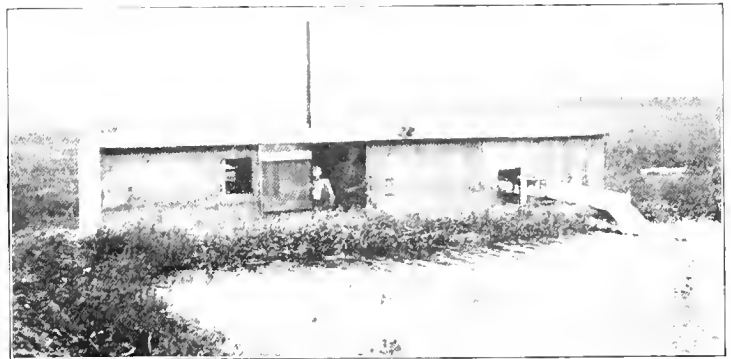
This is a particularly well designed plant. The engine is the latest type I H C oil engine, and the pump and other equipment is the best. The complete outfit is well housed.



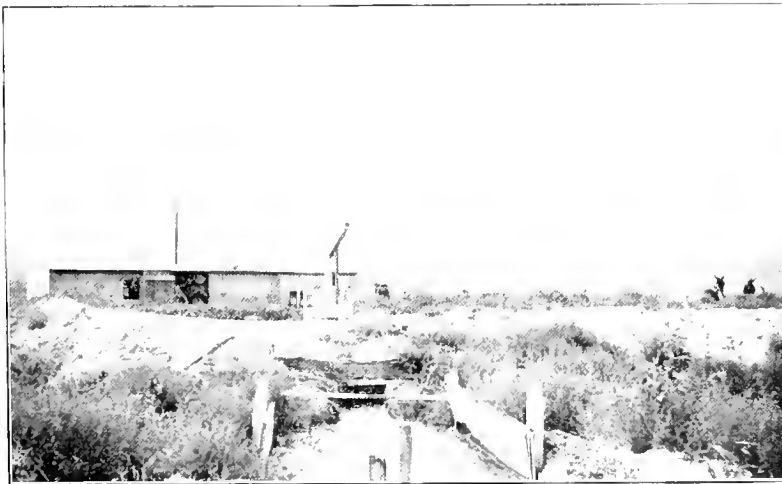
The house—showing the old windmill for stock



The engine used—an I H C 15-H. P.
Titan oil engine



The power house and reservoir



Reservoir gate and discharge ditch



Main supply ditch

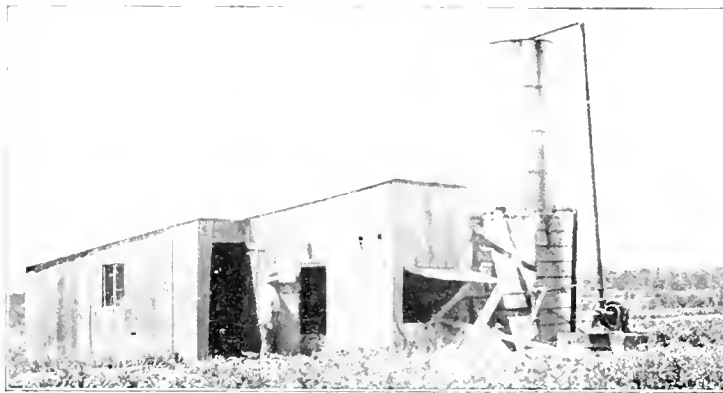
MECHANICAL IRRIGATION

An Irrigated Truck Farm

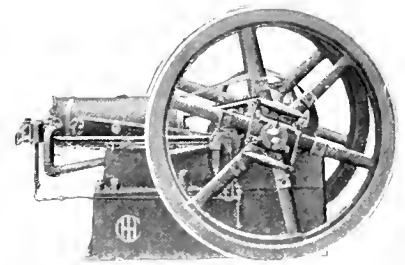
An example of what an I H C irrigation plant will do can be seen on this 8-acre Hutchinson, Kans., truck garden. Garden crops of all kinds are grown for the market. The power plant is a 4-H. P. I H C engine and No. 2 centrifugal pump, pumping from a 16-inch diameter, 22-foot well against a total head of 32 feet. The water is pumped into an elevated tank and run to different parts of the orchard as needed, 1,500 feet of 4-inch iron pipe with plugs at convenient points being used for this purpose. This irrigation plant has been in use eight months in the year for eight years, and giving as good service as new.



The Curtis home



Power house and supply tank



The engine used — an I H C Titan 4-H. P. gasoline engine



Method of running water down the rows



Prize garden products from the Curtis farm



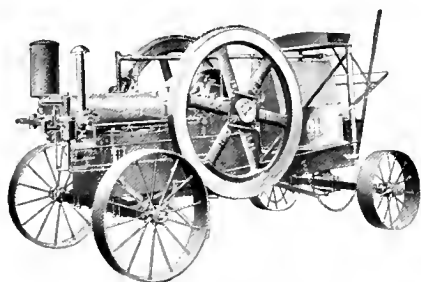
MECHANICAL IRRIGATION



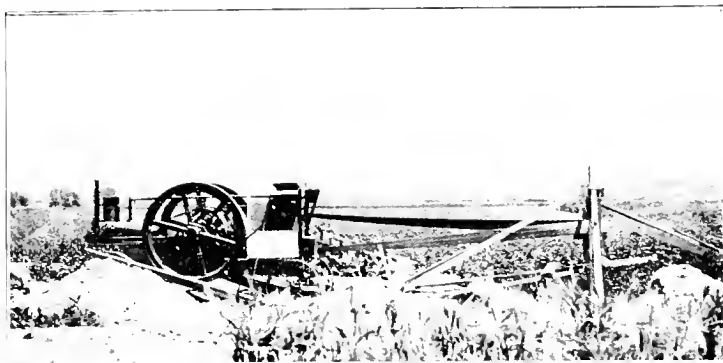
A rear view of the farm house

An Irrigated Small Grain Farm

This 80-acre Longmont, Colo., farm uses an I H C 20-H. P. portable oil engine for irrigating wheat and oats. This type of engine is convenient where there is other work such as threshing to be done on the farm, as the engine can be easily hauled around wherever there is work for it to do. It burns kerosene, distillate, solar oil, gas oil, motor spirit or gasoline. The pump is a No. 6 centrifugal, pumping from a creek bottom. The water is distributed by means of 900 feet of 12-inch iron pipe to different parts of the field. This is a modern outfit in every respect.



The engine used—an I H C Titan 20-H. P portable oil engine



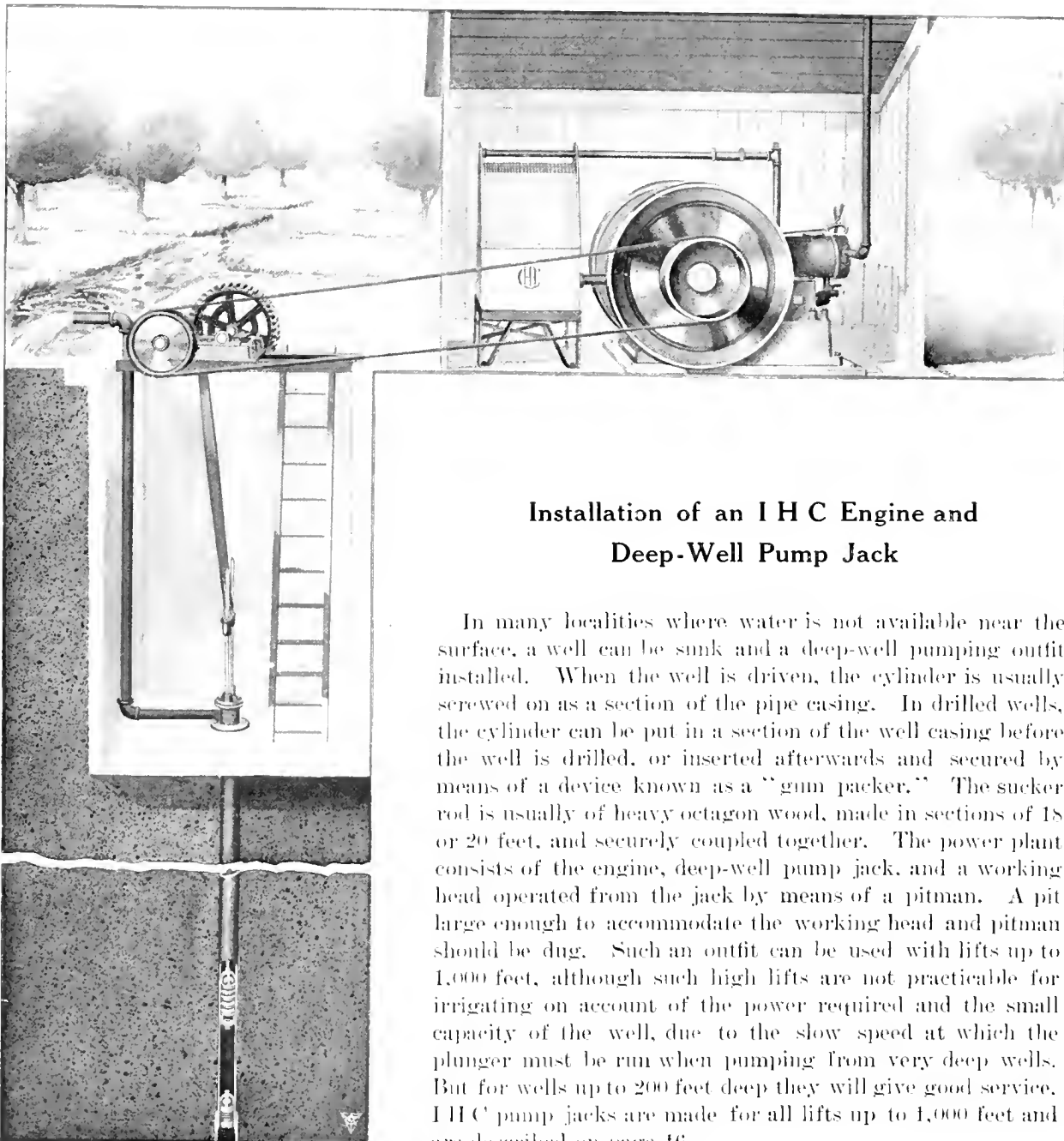
The power plant and pump frame



Method of running water through the fields

MECHANICAL IRRIGATION

Deep-Well Pumping Outfit

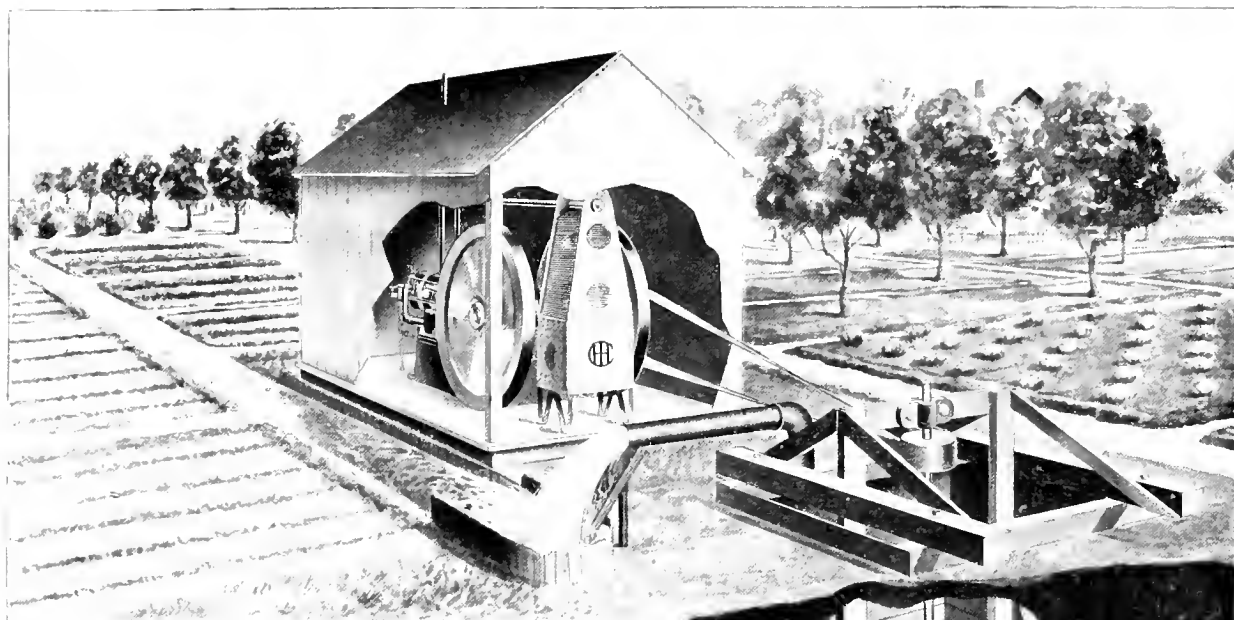


Installation of an I H C Engine and Deep-Well Pump Jack

In many localities where water is not available near the surface, a well can be sunk and a deep-well pumping outfit installed. When the well is driven, the cylinder is usually screwed on as a section of the pipe casing. In drilled wells, the cylinder can be put in a section of the well casing before the well is drilled, or inserted afterwards and secured by means of a device known as a "gum packer." The sucker rod is usually of heavy octagon wood, made in sections of 18 or 20 feet, and securely coupled together. The power plant consists of the engine, deep-well pump jack, and a working head operated from the jack by means of a pitman. A pit large enough to accommodate the working head and pitman should be dug. Such an outfit can be used with lifts up to 1,000 feet, although such high lifts are not practicable for irrigating on account of the power required and the small capacity of the well, due to the slow speed at which the plunger must be run when pumping from very deep wells. But for wells up to 200 feet deep they will give good service. I H C pump jacks are made for all lifts up to 1,000 feet and are described on page 16.

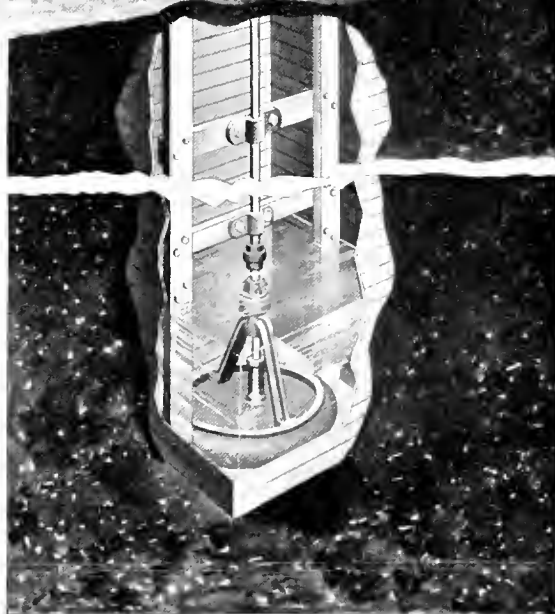
MECHANICAL IRRIGATION

Shallow-Well Pumping Outfits



Installation of I H C Engine and Vertical Suction Centrifugal Pump

Where water can be reached by digging, the vertical suction centrifugal pump is the most economical outfit for irrigation. The well should be of ample size to supply the pump and should be curbed or securely cased with timber. The pump may be either bolted in the bottom of the well or suspended in the well in a gallows frame, similar to the illustration. Care must be taken to have the pump pulley on a level with the engine pulley to keep the belt from running off. It is always best to submerge the pump where possible, otherwise it requires priming when starting. Often a combination of the dug and drilled well is used where water is found at too great a depth to allow of digging the well all the way. The pump



is set in the bottom of the dug well and the intake coupled to the casing of the drilled well. Where the ordinary single stage centrifugal pump is used, the lift should not be over 40 or 50 feet to secure the best economy. For high lifts, two or three-stage centrifugal pumps may be used.



MECHANICAL IRRIGATION



I H C Engines

The I H C line of engines offers unequalled opportunity for selecting efficient and economical power, and enables you to choose an I H C engine of a size and type especially adapted to your individual needs. One of the greatest advantages of I H C engines for irrigating, is their adaptability to all other power purposes on the farm. After the crops are harvested, they will furnish power



I H C engine irrigating near Stockton, Cal.

to operate threshers, feed grinders, wood saws, clover hullers, ensilage cutters, huskers and shredders, fodder cutters, pumps for domestic water supply, electric light outfits, and the like.

The smaller engines can be used to run electric light plants, pump water for domestic use, run cream separators, churns, washing machines, grindstones, wood saws, corn shellers, feed grinders, fanning mills, and many other machines.

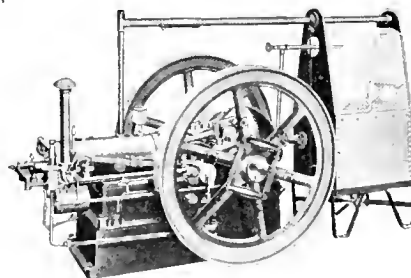
Construction of I H C Oil Engines

The efficiency of your irrigation system depends upon the efficiency of the power that operates it. To be a profitable investment, an engine must be properly designed, and be constructed so as to last many years.

I H C oil engines are always a safe selection. Their efficiency has been proved. They have years of success behind them. There are thousands in use. Their construction embodies the greatest simplicity and strength. Their design insures the most power and the least fuel. They are the easiest to operate, and thoroughly reliable under the most severe conditions of service, and they always develop more than their rated horse power. They may be had in sizes from 1 to 50-horse power, built to operate on gas, gasoline, kerosene, distillate, solar oil, gas oil or motor spirit.

I H C Horizontal Oil Engines

These engines are especially adapted for installation in power houses. They take up but little space, therefore a large, costly power house is unnecessary.



I H C Titan stationary oil engine, 4, 6, 8, 10, 12, 15, 20 and 25-H. P.

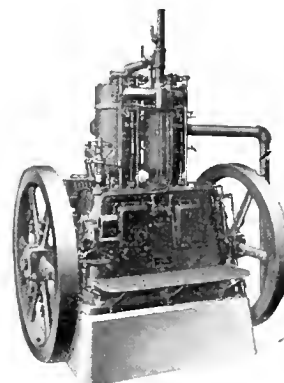
I H C Stationary horizontal engines are made in the following sizes: Tank cooled—4, 6, 8, 10, 12, 15, 20, 25, and 50-horse power; hopper cooled—1, 1³/₄, 2¹/₂, 4, 6, 8, and 10-horse power.

I H C Stationary vertical engines are made in the following sizes: Tank cooled—2 and 3-horse power.

I H C Two-Cylinder Oil Engine

I H C two-cylinder vertical oil engines are especially adapted for large irrigation installations.

They are very economical in fuel consumption under either light or heavy loads. After starting, they need but little attention; therefore, a special engineer is not necessary. Only a small shed is required to cover this outfit as it occupies but little space.



I H C Titan 2-Cylinder vertical oil engine built in two sizes—25 and 35-H. P.

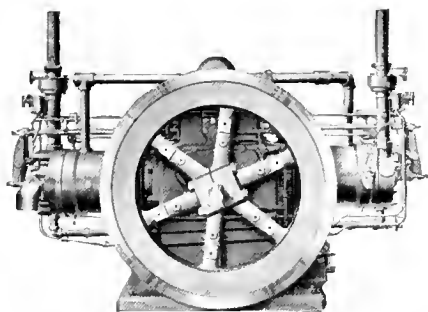


MECHANICAL IRRIGATION



I H C Large Horizontal Engines

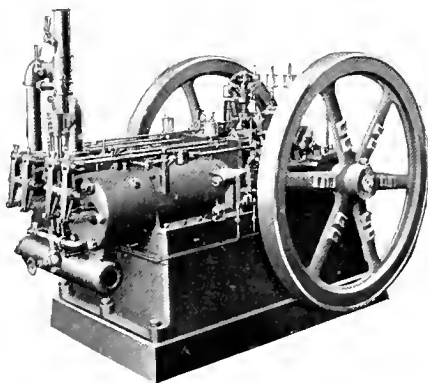
I H C 50-H. P. oil engines are designed for heavy duty and close regulation. They are equipped with mechanical force feed oiling system, throttling governor and air starter. They operate on the



IHC Mogul kerosene 2-cylinder opposed, 50-H. P.

cheapest fuel, such as kerosene, distillate, solar oil, gas oil, etc., but will operate equally well on motor spirit, gasoline or naphtha.

On special order they can be equipped to operate on gas. The throttling governor feature and heavy flywheels make them especially adapted for all classes of machinery that require close regulation. They are very economical in operation as they will burn the cheapest fuels with no more attention than is required by gasoline.

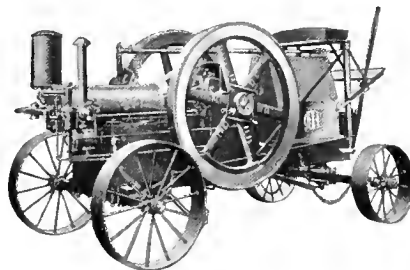


IHC Titan twin-cylinder oil engine

The construction and finish throughout is of the highest class and they will give reliable service under the most severe condition.

I H C Portable Oil Engines

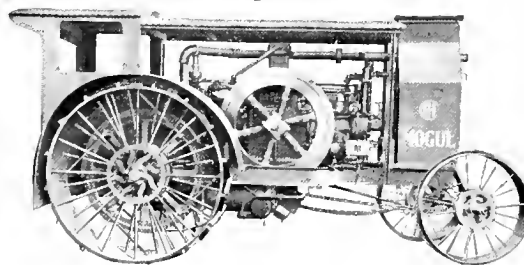
These engines meet the demand for a power which can be easily moved from place to place. They are much lighter than portable steam outfits, therefore easier to handle; will not mire so easily



IHC Titan portable tank-cooled, 4, 6, 8, 10, 12, 15, 20 and 25-H. P.

in soft, irrigated ground, and can be hauled to places where it would be impossible to take a steam outfit. The trucks are built exceptionally strong, and will stand the wear and tear of the roughest roads.

IHC horizontal portable oil engines are made in the following sizes: Tank cooled—4, 6, 8, 10, 12, 15, 20, and 25-horse power; hopper cooled—4, 6, and 8-horse power. IHC vertical portable engine—2 and 3-horse power.



IHC Mogul 30-60-H. P. oil tractor

I H C Tractors

IHC oil tractors are the ideal portable power for either hauling or belt work. They deliver the most power at the belt and the most power at the drawbar for the amount of fuel consumed. On large farms they will reduce to a surprising extent the expense for the heavy work.

With an IHC tractor you can do the irrigating, threshing, and other belt work to the best advantage, and the plowing, seeding, disking, harrowing, harvesting, and hauling much cheaper than with horses.

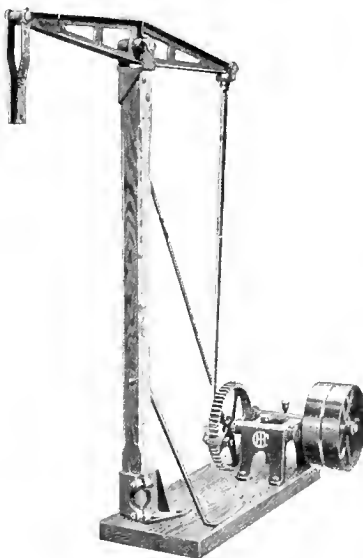
IHC oil tractors are made in the following sizes: 6-12, 8-15, 10-20, 12-25, 15-30, 18-35, 30-60-H. P.

MECHANICAL IRRIGATION

I H C Pump Jacks



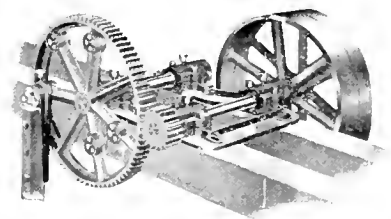
I H C Famous 2-H. P. Pumping Engine



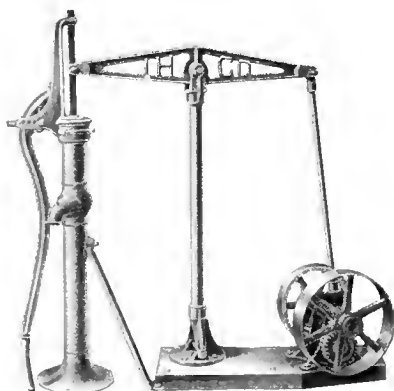
I H C Walking-Beam Pumping Jack No. 2



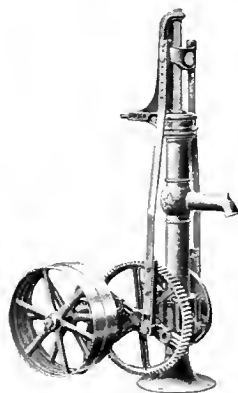
I H C Standard Pumping Jack No. 2



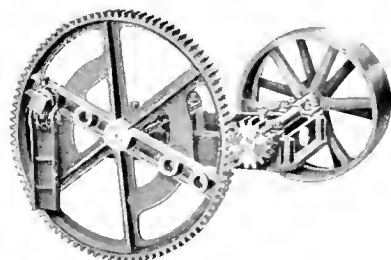
I H C Heavy-Belted Pumping Jack



I H C Walking-Beam Pumping Jack No. 1



I H C Standard Pumping Jack No. 1



I H C Deep-Well Belted Pumping Jack

Specifications of I H C Pump Jacks

TYPE OF PUMP JACK	Maximum Head, Feet	Length of Stroke, Inches	Strokes Per Minute	Size of Engine ¹ to be used with	Ratio of Gears	PULLEY		
						Size Inches	Face Inches	Speed R.P.M.
Standard No. 1	100' with 2 1/4" Cyl.	5, 7, 9, 11	40	2-H. P.	5.7 to 1	14 1/2	2 1/2	230
Standard No. 2	200' with 2 1/4" Cyl.	5, 7, 9, 11	40	2 H. P.	5.7 to 1	11 1/2	2 1/2	230
Walking Beam No. 1	100' with 2 1/4" Cyl.	5 to 9 3/4	40	2 H. P.	7.1 to 1	13 1/2	2 1/2	285
Walking Beam No. 2	200' with 4 1/2" Cyl.	5, 7, 10	40	2 to 3-H. P.	4.6 to 1	14	3	185
Regular Belted Jack	200' with 4 1/2" Cyl.	5, 7, 10	40	2 to 3-H. P.	4.6 to 1	11	3	185
Heavy Belted Jack	up to 400 ft.	12, 14, 15, 18, 20,	32	2 to 6-H. P.	5 to 1	24	4 1/2	164
Deep-Well Jack	1000' with 4" Cyl.	12, 18, 24, 28	30	2 to 12-H. P.	6 to 1	24	6	180
Deep-Well Jack	1000' with 4" Cyl.	12, 18, 24, 28	24	2 to 12-H. P.	7.5 to 1	24	6	180

¹When pump jacks are used to pump with a smaller head, the size of the pump cylinder can be increased.

MECHANICAL IRRIGATION

Centrifugal Pumps

Centrifugal pumps are particularly adapted for irrigation wherever the suction lift is not over 20 feet. They are extremely simple, having neither cylinders nor valves. They will handle dirty water charged with sand, gravel and light organic



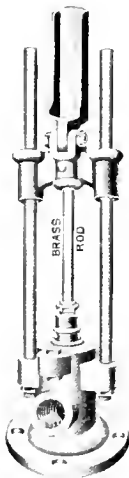
Vertical suction centrifugal irrigating pumps
For use in irrigating from dug wells

matter and they discharge a surprisingly large column of water; centrifugal pumps are made in sizes with from 1 to 20-inch discharge and can be furnished in two types.

The vertical suction type is designed for use in dug wells, at the bottom of shafts, deep ditches, etc. A frame is usually constructed to carry the shaft bearings, and the pump is bolted to the lower end. It is the practice wherever possible to submerge this type of centrifugal pump so that no priming is necessary.

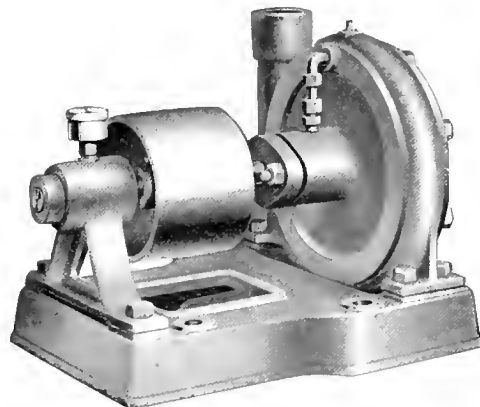


Deep-well cylinders



Working head

The side suction centrifugal pump is used for pumping from lakes, streams, etc. They can also be used in shallow pits where the angle of the belt is not too steep by digging out a trench on one side to accommodate the belt.



Side suction centrifugal irrigating pumps
For use in irrigation from lakes, rivers or streams

With this type of pump it is usually necessary to use a small priming pump operated by hand in order to start the water.

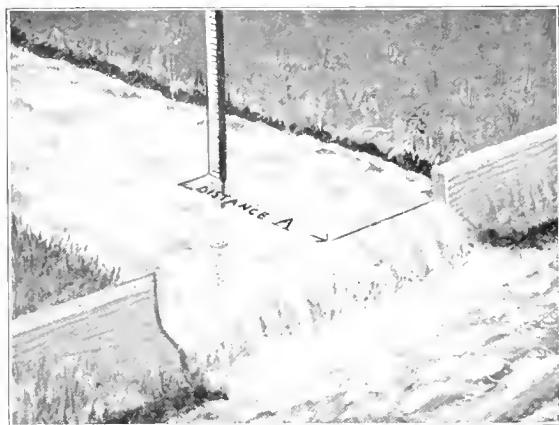
Deep-Well Cylinders

In drilled or drive wells which are too deep to allow the use of a vertical suction centrifugal pump, deep-well cylinders must be used. The most common and satisfactory type of well cylinder is inserted by the manufacturer in one section of the well casing and is a permanent part of the well. The valves are provided with threaded lugs to which the pump plunger can be screwed so that the valves can be lifted out of the well when necessary. The cuts show two types of cylinders, one with poppet valves and one with ball valves. These cylinders are made in sizes from 2 to 10-inch well casing.

When this type of pump is used, a pump jack and working head are necessary. The illustration shows the common type of working head. On page 16 the different types of IHC pump jacks are shown. These jacks are in general use for irrigation and can be relied on under all circumstances. Page 12 shows a complete outfit pumping from a drilled well with a shallow dug pit.

MECHANICAL IRRIGATION

The Weir Dam for Measuring the Flow of Water in the Stream or Ditch



The Weir Dam Table given below shows the number of cubic feet of water passing per minute over the notch, for each inch in breadth.

Example

Suppose the notch in the board is 20 inches wide, and the water is $5\frac{1}{2}$ inches above the top of the stake. In the table, at $5\frac{1}{2}$ inches, it is shown that 5.18 cubic feet flow over one inch of width. Multiply this by 20 (width of notch), and you will have 103.6, which represents the cubic feet of water passing over the weir, or amount in the stream. Since one cubic foot equals 7.48 gallons, 103.6 cubic feet equals 774.928 gallons, or approximately 65 Montana miners' inches.

The table given is not absolutely exact, but will give a result near enough for practical purposes.

Directions for Making Weir Dams

Cut a notch in a board deep enough to pass all the water, and occupying about two-thirds the width of the stream. Bevel the edges of the notch, then secure it in the position shown in the above view. Fix the ends and bottom of the board so that no water will leak out around the edges. Drive a stake in the bottom of the stream about 4 or 5 feet from the board (shown as distance A in the view). The top of the stake must be exactly level with the bottom of the notch in the board. After the water has come to an even flow and reached its greatest depth, a careful measurement can be made of the depth of the water over the top of the stake. This measurement gives the true depth of the water passing over the notch. On the downward side, the water must have a drop of 10 to 15 inches after leaving the board, to enable you to get the true flow.

The nature of the channel above the board should be such that the water will not rush over the board, but should be wide and deep enough to allow it to flow over quietly.

Table for Weir Dam Measurement

Giving Cubic Feet of Water per Minute that Will Flow Over a Weir One Inch Wide at the Various Depths Given Therein

Inches in Depth	Cu. Ft. per Min.	Inches in Depth	Cu. Ft. per Min.	Inches in Depth	Cu. Ft. per Min.	Inches in Depth	Cu. Ft. per Min.	Inches in Depth	Cu. Ft. per Min.	Inches in Depth	Cu. Ft. per Min.
1	.40	4	3.22	7	7.44	10	12.71	13	18.87	16	25.75
1 $\frac{1}{8}$	.47	4 $\frac{1}{8}$	3.37	7 $\frac{1}{8}$	7.64	10 $\frac{1}{8}$	12.95	13 $\frac{1}{8}$	19.14	16 $\frac{1}{8}$	26.06
1 $\frac{1}{4}$	.55	4 $\frac{1}{4}$	3.52	7 $\frac{1}{4}$	7.84	10 $\frac{1}{4}$	13.19	13 $\frac{1}{4}$	19.42	16 $\frac{1}{4}$	26.36
1 $\frac{3}{8}$	.65	4 $\frac{3}{8}$	3.68	7 $\frac{3}{8}$	8.05	10 $\frac{3}{8}$	13.43	13 $\frac{3}{8}$	19.69	16 $\frac{3}{8}$	26.66
1 $\frac{1}{2}$	.74	4 $\frac{1}{2}$	3.83	7 $\frac{1}{2}$	8.25	10 $\frac{1}{2}$	13.67	13 $\frac{1}{2}$	19.97	16 $\frac{1}{2}$	26.97
1 $\frac{5}{8}$	.83	4 $\frac{5}{8}$	3.99	7 $\frac{5}{8}$	8.45	10 $\frac{5}{8}$	13.93	13 $\frac{5}{8}$	20.24	16 $\frac{5}{8}$	27.27
1 $\frac{3}{4}$	.93	4 $\frac{3}{4}$	4.16	7 $\frac{3}{4}$	8.66	10 $\frac{3}{4}$	14.16	13 $\frac{3}{4}$	20.52	16 $\frac{3}{4}$	27.58
1 $\frac{7}{8}$	1.03	4 $\frac{7}{8}$	4.32	7 $\frac{7}{8}$	8.86	10 $\frac{7}{8}$	14.42	13 $\frac{7}{8}$	20.80	16 $\frac{7}{8}$	27.89
2	1.14	5	4.50	8	9.09	11	14.67	14	21.09	17	28.20
2 $\frac{1}{8}$	1.24	5 $\frac{1}{8}$	4.67	8 $\frac{1}{8}$	9.31	11 $\frac{1}{8}$	14.92	14 $\frac{1}{8}$	21.37	17 $\frac{1}{8}$	28.51
2 $\frac{1}{4}$	1.36	5 $\frac{1}{4}$	4.84	8 $\frac{1}{4}$	9.52	11 $\frac{1}{4}$	15.18	14 $\frac{1}{4}$	21.65	17 $\frac{1}{4}$	28.82
2 $\frac{3}{8}$	1.47	5 $\frac{3}{8}$	5.01	8 $\frac{3}{8}$	9.74	11 $\frac{3}{8}$	15.43	14 $\frac{3}{8}$	21.94	17 $\frac{3}{8}$	29.14
2 $\frac{1}{2}$	1.59	5 $\frac{1}{2}$	5.18	8 $\frac{1}{2}$	9.96	11 $\frac{1}{2}$	15.67	14 $\frac{1}{2}$	22.22	17 $\frac{1}{2}$	29.45
2 $\frac{5}{8}$	1.71	5 $\frac{5}{8}$	5.36	8 $\frac{5}{8}$	10.18	11 $\frac{5}{8}$	15.96	14 $\frac{5}{8}$	22.51	17 $\frac{5}{8}$	29.76
2 $\frac{3}{4}$	1.83	5 $\frac{3}{4}$	5.54	8 $\frac{3}{4}$	10.40	11 $\frac{3}{4}$	16.20	14 $\frac{3}{4}$	22.79	17 $\frac{3}{4}$	30.08
2 $\frac{7}{8}$	1.96	5 $\frac{7}{8}$	5.72	8 $\frac{7}{8}$	10.62	11 $\frac{7}{8}$	16.46	14 $\frac{7}{8}$	23.08	17 $\frac{7}{8}$	30.39
3	2.09	6	5.90	9	10.86	12	16.73	15	23.38	18	30.70
3 $\frac{1}{8}$	2.23	6 $\frac{1}{8}$	6.09	9 $\frac{1}{8}$	11.08	12 $\frac{1}{8}$	16.99	15 $\frac{1}{8}$	23.67	18 $\frac{1}{8}$	31.02
3 $\frac{1}{4}$	2.36	6 $\frac{1}{4}$	6.28	9 $\frac{1}{4}$	11.31	12 $\frac{1}{4}$	17.26	15 $\frac{1}{4}$	23.97	18 $\frac{1}{4}$	31.34
3 $\frac{3}{8}$	2.50	6 $\frac{3}{8}$	6.47	9 $\frac{3}{8}$	11.54	12 $\frac{3}{8}$	17.52	15 $\frac{3}{8}$	24.26	18 $\frac{3}{8}$	31.66
3 $\frac{1}{2}$	2.63	6 $\frac{1}{2}$	6.65	9 $\frac{1}{2}$	11.77	12 $\frac{1}{2}$	17.78	15 $\frac{1}{2}$	24.56	18 $\frac{1}{2}$	31.98
3 $\frac{5}{8}$	2.78	6 $\frac{5}{8}$	6.85	9 $\frac{5}{8}$	12.00	12 $\frac{5}{8}$	18.05	15 $\frac{5}{8}$	24.86	18 $\frac{5}{8}$	32.31
3 $\frac{3}{4}$	2.92	6 $\frac{3}{4}$	7.05	9 $\frac{3}{4}$	12.23	12 $\frac{3}{4}$	18.32	15 $\frac{3}{4}$	25.15	18 $\frac{3}{4}$	32.63
3 $\frac{7}{8}$	3.07	6 $\frac{7}{8}$	7.25	9 $\frac{7}{8}$	12.47	12 $\frac{7}{8}$	18.58	15 $\frac{7}{8}$	25.46	18 $\frac{7}{8}$	32.96

MECHANICAL IRRIGATION

Measurements Used in Figuring Irrigation Problems

Standing water—Figured in cubic feet.
 Irrigating water—Acre inch or acre foot.
 Flowing water } Cubic feet per second
 1 gallon } Miners' inch
 1 acre foot—43,560 cubic feet.
 1 acre foot—325,829 gallons per minute.
 1 acre inch—3,630 cubic feet.
 1 cubic foot—7½ gallons.
 1 cubic foot per second—second foot.
 1 second foot—450 gallons per minute.
 1 second foot (continuous flow) 2 acre feet in 24 hours.

Miners' inch—Quantity of water flowing through an aperture 1 inch square under a head of (in Colorado and Idaho, 4"). (in California and Montana 6").
 100 California Miners' inch—4 acre feet in 21 hours.
 100 Colorado Miners' inch—5½ acre feet in 24 hours.
 225 gallons per minute—Cover 1 acre 1 inch deep in 2 hours, 21 minutes.
 Cubic feet per second—The cross section x the velocity can be obtained by timing a float for a measured distance.
 Doubling the diameter of a pipe increases its capacity four times.

Friction of Water in Clean Iron Pipes (Figured in Feet Head)

Feet Head to be added to each 100 feet of Pipe
 Ellis & Howland's Experiments

Gallons Per Min. Delivered	¾ In.	1 In.	1¼ In.	1½ In.	2 In.	2½ In.	3 In.	3½ In.	4 In.	5 In.	6 In.
5	7.6	1.9	.71	.27	.09	.05	.01	—	—	—	—
10	29.9	7.3	1.1	1.0	.28	.09	.05	.01	—	—	—
15	66.0	16.1	5.5	2.2	.57	.18	.09	.05	.02	—	—
20	115.0	28.0	9.5	1.8	.96	.32	.13	.07	.03	.01	—
25	179.	43.7	11.7	6.0	1.7	.48	.23	.09	.05	.02	.01
30	261.	63.2	21.0	8.6	2.1	.69	.30	.11	.07	.03	.01
35	372.	85.1	28.9	11.6	2.7	.92	.39	.20	.11	.04	.02
40	461.	110.	37.0	11.9	3.7	1.2	.53	.25	.11	.05	.02
45	591.	145.	46.5	18.7	4.6	1.5	.61	.32	.16	.07	.02
50	—	185.	57.3	23.0	5.6	1.9	.80	.39	.20	.09	.03
60	—	253.	82.8	32.2	8.0	2.7	1.2	.55	.30	.11	.05
70	—	340.	116.	46.0	11.0	3.5	1.4	.87	.41	.16	.06
80	—	393.	129.	51.1	12.2	4.1	1.7	.90	.48	.17	.07
90	—	442.	147.	57.5	11.5	4.6	2.0	.93	.53	.18	.07
100	—	580.	181.	73.6	17.9	5.9	2.5	1.1	.60	.21	.09
125	—	—	238.	89.7	21.7	7.3	2.9	1.5	.71	.27	.11
150	—	—	307.	150.	31.3	10.0	4.6	2.4	1.2	.39	.16
175	—	—	516.	207.	48.8	16.1	6.5	3.4	1.6	.57	.23
200	—	—	—	291.	61.6	21.7	8.6	4.2	2.1	.78	.30
250	—	—	—	359	86.2	28.6	11.5	5.1	2.8	.96	.39
300	—	—	—	600.	137.	41.7	17.7	8.5	4.3	1.5	.60
350	—	—	—	—	195.	61.4	25.7	11.5	6.2	2.1	.85
400	—	—	—	—	258.	86.8	34.9	16.3	8.4	2.9	1.1
450	—	—	—	—	345.	111.	44.9	21.3	10.9	3.7	1.5

Friction of Water in Elbows (Figured in Feet Head)

Feet Head to be added for each Elbow
 Table based on Weisbach's Formula for very short bends

Gallons per Min. Delivered	PIPE SIZES—INSIDE DIAMETER										
	¾	1	1¼	1½	2	2½	3	3½	4	5	6
5	.161	.0621	.0181	.0115	.0046	—	—	—	—	—	—
10	.641	.2162	.0713	.0411	.0128	.0069	—	—	—	—	—
15	1.419	.4876	.1587	.92	.0322	.0115	—	—	—	—	—
20	2.576	.8648	.2229	.1587	.0575	.0276	.0115	—	—	—	—
25	4.002	1.3455	.4162	.2481	.0871	.046	.0181	—	—	—	—
30	—	1.9435	.6391	.3611	.1265	.0644	.0253	—	—	—	—
35	—	2.645	.8746	.4915	.1748	.0851	.0345	.0207	—	—	—
40	—	3.450	1.1385	.6301	.2251	.1127	.046	.0253	.0161	—	—
45	—	4.370	1.4389	.8096	.2875	.1429	.0598	.0345	.0247	—	—
50	—	—	1.771	.989	.3519	.181	.0736	.0391	.024	—	—
60	—	—	2.774	2.553	1.126	.506	.2576	.1012	.0598	.0345	.0138
70	—	—	10.580	3.436	1.978	.6092	.3494	.138	.085	.0483	.0207
80	—	—	12.190	1.002	2.251	.805	.3356	.1656	.102	.0552	.023
90	—	—	13.800	1.551	2.553	.9046	.4508	.181	.1012	.0621	.0273
100	—	—	17.180	5.750	3.243	1.150	.5501	.2302	.138	.0805	.0323
125	—	—	—	7.081	3.956	1.4976	.736	.2911	.1564	.0989	.0391
150	—	—	—	—	6.256	2.234	1.104	.460	.2556	.1541	.0621
175	—	—	—	—	9.016	3.197	1.5755	.6578	.368	.2208	.0895
200	—	—	—	—	12.246	1.370	2.1505	.8970	.5014	.3036	.1219
250	—	—	—	—	15.821	5.612	2.911	1.776	.6266	.3656	.1561
300	—	—	—	—	—	8.878	1.303	1.810	.9258	.6164	.2507
400	—	—	—	—	—	12.788	6.392	2.622	1.472	.8832	.3588

Friction of Water in Pipes (Figured in Pounds Pressure)

Friction loss in pounds pressure per square inch for each 100 feet of length in different size clean iron pipe, discharging given quantities of water per minute.

Gallons per Min.	SIZE OF PIPE—INSIDE DIAMETER											
	1 in.	1½ in.	2 in.	2½ in.	3 in.	4 in.	5 in.	6 in.	8 in.	10 in.	12 in.	
5	0.84	0.12	0.03	—	—	—	—	—	—	—	—	
10	3.16	0.47	0.12	0.03	—	—	—	—	—	—	—	
15	6.98	0.97	0.27	0.06	—	—	—	—	—	—	—	
20	12.3	1.66	0.42	0.13	0.03	—	—	—	—	—	—	
25	19.0	2.62	0.67	0.21	0.10	—	—	—	—	—	—	
30	27.5	3.75	0.91	0.30	0.12	0.03	—	—	—	—	—	
35	37.0	5.05	1.26	0.42	0.14	0.05	—	—	—	—	—	
40	48.0	6.52	1.60	0.51	0.17	0.06	—	—	—	—	—	
45	—	8.15	2.01	0.62	0.27	0.07	—	—	—	—	—	
50	—	10.0	2.44	0.81	0.35	0.09	0.03	—	—	—	—	
75	—	22.4	5.32	1.80	0.71	0.21	0.06	0.03	—	—	—	
100	—	39.0	9.46	3.20	1.31	0.33	0.12	0.05	—	—	—	
125	—	—	11.9	4.89	1.99	0.51	0.17	0.07	—	—	—	
150	—	—	21.2	7.0	2.85	0.69	0.25	0.10	0.02	—	—	
175	—	—	28.1	9.46	3.85	0.95	0.34	0.14	0.03	—	—	
200	—	—	37.5	12.47	5.02	1.22	0.42	0.17	0.05	0.01	—	
250	—	—	—	19.66	7.76	1.89	0.65	0.26	0.07	0.03	0.01	
300	—	—	—	28.06	11.02	2.66	0.93	0.37	0.09	0.04	0.01	

Gallons	SIZE OF PIPE—INSIDE DIAMETER											
	3 in.	4 in.	5 in.	6 in.	8 in.	10 in.	12 in.	14 in.	16 in.	18 in.	20 in.	
350	15.2	3.65	1.28	0.50	0.12	0.05	0.02	-----	-----	-----	-----	
400	19.5	1.73	1.68	0.65	0.16	0.06	0.02	-----	-----	-----	-----	
450	25.0	6.04	2.10	0.81	0.20	0.07	0.03	-----	-----	-----	-----	
500	30.8	7.43	2.70	0.96	0.25	0.09	0.04	0.017	0.009	0.005	-----	
600	-----	10.6	3.15	1.72	0.348	0.13	0.05	0.024	0.013	0.007	-----	
750	-----	16.5	5.10	2.21	0.53	0.18	0.08	0.038	0.019	0.011	-----	
1000	-----	-----	9.60	3.88	0.91	0.32	0.13	0.062	0.036	0.018	-----	
1250	-----	-----	-----	6.07	1.46	0.49	0.20	0.095	0.050	0.028	-----	
1500	-----	-----	-----	8.71	2.69	0.70	0.29	0.135	0.071	0.040	-----	
1750	-----	-----	-----	11.83	2.81	0.95	0.38	0.180	0.095	0.053	-----	
2000	-----	-----	-----	15.43	3.69	1.23	0.49	0.234	0.123	0.069	-----	
2500	-----	-----	-----	-----	5.75	1.90	0.77	0.362	0.188	0.107	-----	
3000	-----	-----	-----	-----	-----	2.73	1.11	0.515	0.267	0.15	0.09	
3500	-----	-----	-----	-----	-----	-----	1.50	0.697	0.365	0.204	0.124	
4000	-----	-----	-----	-----	-----	-----	-----	0.91	0.47	0.264	0.158	
4500	-----	-----	-----	-----	-----	-----	-----	1.15	0.593	0.33	0.20	
5000	-----	-----	-----	-----	-----	-----	-----	-----	0.73	0.41	0.241	

MECHANICAL IRRIGATION

Table for Converting Pressure per Square Inch into Feet Head of Water

Pounds per Square Inch	Feet Head	Pounds per Square Inch	Feet Head	Pounds per Square Inch	Feet Head
1	2.31	55	126.90	180	415.61
2	4.62	60	138.51	190	438.90
3	6.93	65	150.08	200	461.78
4	9.24	70	161.63	225	519.51
5	11.54	75	173.17	250	577.24
6	13.85	80	184.72	275	634.93
7	16.16	85	196.26	300	692.69
8	18.47	90	207.81	325	750.41
9	20.78	95	219.35	350	808.13
10	23.09	100	230.90	375	865.89
15	34.63	110	253.98	400	923.58
20	46.18	120	277.07	500	1154.48
25	57.72	125	288.62		
30	69.27	130	300.16		
35	80.81	140	323.25		
40	92.36	150	346.34		
45	103.90	160	369.43		
50	115.45	170	392.52		

Table for Converting Feet Head of Water into Pressure per Square Inch

Feet Head	Pounds per Square Inch	Feet Head	Pounds per Square Inch	Feet Head	Pounds per Square Inch
1	.43	55	23.82	190	82.29
2	.87	60	25.90	200	86.62
3	1.30	65	28.15	225	97.45
4	1.73	70	30.32	250	108.27
5	2.17	75	32.48	275	119.10
6	2.60	80	34.65	300	129.93
7	3.03	85	36.81	325	140.75
8	3.46	90	38.98	350	151.58
9	3.90	95	41.14	375	162.41
10	4.33	100	43.31	400	173.24
15	6.50	110	47.64	500	216.55
20	8.66	120	51.97	600	259.85
25	10.83	130	56.30	700	303.16
30	12.99	140	60.63	800	346.47
35	15.16	150	64.96	900	389.78
40	17.32	160	69.29	1000	433.09
45	19.49	170	73.63		
50	21.65	180	77.96		

Power Required to Elevate Water to Different Heights (with Gould's Centrifugal Pump)

No. Pump	Capacity Gallons per min.	H. P. per ft. elevation	SPEED OF PUMP, REVOLUTIONS PER MINUTE									
			5 Feet	10 Feet	15 Feet	20 Feet	25 Feet	30 Feet	35 Feet	40 Feet	50 Feet	60 Feet
1	30	.025	963	1176	1357	1515	1656	1790	1911	2028	-----	-----
1½	70	.058	642	781	901	1010	1104	1193	1274	1352	1493	1622
1¾	90	.075	473	579	651	721	790	850	906	950	1058	1147
2	120	.10	364	443	511	570	623	672	718	762	840	913
2½	185	.15	389	478	500	547	590	630	667	703	770	830
3	265	.22	356	439	449	475	517	559	599	636	704	766
3½	330	.26	352	443	455	513	555	595	632	667	733	793
4	470	.39	321	390	415	493	539	580	618	651	721	771
5	735	.45	311	368	418	462	502	532	574	606	666	722
6	1060	.59	247	300	345	385	421	453	484	513	566	615
8	2000	1.00	203	245	300	420	466	500	532	561	617	667
10	3000	1.52	160	226	278	320	378	402	424	456	506	555
12	4300	2.00	133	188	230	266	298	326	352	376	421	461
15	7000	3.50	151	213	261	304	347	369	389	426	477	522
18	10000	4.50	151	213	261	304	337	369	399	426	477	522

Irrigation Quantity Tables

AMOUNT OF WATER REQUIRED TO COVER ONE ACRE TO GIVEN DEPTHS			SECOND FEET REDUCED TO GALLONS AND ACRE FEET				GALLONS REQUIRED TO COVER A GIVEN NUMBER OF ACRES TO A DEPTH OF ONE FOOT ACRE FOOT	
Depth in inches and feet (Acres inches and acre feet)	Cubic feet or second feet contained in one acre to depths given in first column	Gallons	Second feet	Gallons per minute	Gallons per pumping day of 12 hours	Acre feet per pumping day of 12 hours	Acres (or number of acre feet)	Gallons
1 in.	3630	27154	¾	112.2	80790	1.279	1	325851
2 in.	7260	54309	¾	224.4	161579	2.558	2	651703
3 in.	10890	81463	¾	336.6	242369	3.837	3	977554
4 in.	14520	108617	1	448.8	323158	4.917	4	1303406
5 in.	18150	135771	1¼	561.0	403948	6.196	5	1629257
6 in.	21780	162926	1½	673.2	484738	7.475	6	1955109
7 in.	25410	190080	1¾	785.5	565527	8.754	7	2280960
8 in.	29040	217234	2	897.7	646317	10.033	8	2606812
9 in.	32670	244389	2½	1122.1	807896	12.403	9	2932663
10 in.	36300	271542	3	1346.5	969475	14.772	10	3258515
11 in.	39930	298697	3½	1570.9	1229034	17.141	15	4877772
1 ft., 00 in.	43560	325851	4	1795.3	1615792	19.510	20	6517029
1 ft., 2 in.	50820	380460	5	2244.2	1615792	24.986	25	8146286
1 ft., 4 in.	58080	434469	6	2693.0	1938951	29.962	30	9775544
1 ft., 6 in.	65340	488477	7	3141.8	2262109	34.938	40	13034058
1 ft., 8 in.	72600	543086	8	3590.6	2585268	39.914	60	16534087
1 ft., 10 in.	79860	597694	9	4039.5	2908426	44.890	80	20034116
2 ft., 00 in.	87120	651703	10	4488.3	3231585	49.866	100	23136232

One cubic foot of water per second (equal 7.48052 gallons), constant flow is known as the "Second Foot." "The Acre Foot" is the quantity of water required to cover one acre to a depth of one foot.

MECHANICAL IRRIGATION

Capacity of Cylinder Pumps

The figures at the extreme right and left of the table are piston, or plunger, diameters; the line of figures across the top are piston, or plunger, strokes; the figures in the body of the table are the capacity, or displacement, in gallons, corresponding to a single stroke. To find the capacity for one revolution, multiply the capacity for a single stroke by one, two, three, or four for single-acting, single, duplex, triplex, quadruplex respectively, and by two, four, six or eight for double-acting pumps.

Diam. of Cyl. In.	LENGTH OF STROKE IN INCHES, AND CAPACITY OF STROKE IN GALLONS, OF PUMP CYLINDER WITH GIVEN DIAMETER												Diam. of Cyl. In.
	4	5	6	8	10	12	14	15	16	18	20	24	
1 1/4	.0212	.0296	.0319	.0425	.0531	.0637	.0743	.0797	.0848	.0955	.1062	.1271	1 1/4
1 1/2	.0256	.0321	.0385	.0513	.0642	.0771	.0901	.0963	.1027	.1156	.1280	.1511	1 1/2
1 3/4	.0306	.0382	.0459	.0612	.0765	.0918	.1071	.1147	.1224	.1377	.1530	.1836	1 3/4
2	.0416	.0521	.0625	.0833	.1041	.1249	.1457	.1562	.1666	.1874	.2082	.2499	2
2 1/4	.0544	.0680	.0816	.1088	.1360	.1632	.1904	.2041	.2176	.2448	.2720	.3264	2 1/4
2 1/2	.0688	.0862	.1033	.1377	.1721	.2063	.241	.258	.2751	.3066	.3342	.4128	2 1/2
2 3/4	.085	.1062	.1275	.17	.2125	.255	.2975	.3087	.31	.3825	.425	.51	2 3/4
3	.1028	.1285	.1543	.2057	.2571	.3085	.3598	.3855	.4111	.4626	.5142	.617	3
3 1/4	.1224	.1539	.1836	.2448	.3061	.3672	.4284	.459	.4896	.5508	.612	.7344	3 1/4
3 1/2	.1436	.1755	.2154	.2872	.3591	.4312	.503	.5385	.5748	.6466	.7182	.8624	3 1/2
3 3/4	.1666	.2082	.2499	.3332	.4165	.4998	.5831	.6247	.6664	.7497	.833	.9996	3 3/4
4	.1912	.239	.2868	.3824	.478	.5736	.6692	.687	.7648	.8605	.9561	1.147	4
4 1/4	.2176	.272	.3261	.4352	.5441	.6528	.7616	.816	.8704	.9792	1.088	1.3156	4 1/4
4 1/2	.2456	.307	.3681	.4912	.6141	.7368	.8596	.921	.9824	1.105	1.228	1.473	4 1/2
4 3/4	.2751	.3442	.4131	.5462	.6792	.8122	.9452	1.0327	1.1016	1.2303	1.3577	1.6524	4 3/4
5	.3068	.3855	.4692	.6136	.7671	.9204	1.073	1.15	1.2227	1.380	1.534	1.84	5
5 1/4	.34	.425	.51	.68	.85	1.02	1.19	1.275	1.36	1.53	1.7	2.01	5 1/4
5 1/2	.3748	.4685	.5622	.7496	.9371	1.124	1.311	1.405	1.499	1.686	1.874	2.228	5 1/2
5 3/4	.4114	.5142	.6171	.8228	1.0285	1.2342	1.4399	1.5427	1.6456	1.8513	2.057	2.484	5 3/4
6	.4496	.562	.6744	.9092	1.144	1.378	1.613	1.686	1.789	2.022	2.248	2.696	6
6 1/4	.4896	.612	.7344	.9792	1.2240	1.4688	1.7136	1.802	1.9584	2.2032	2.448	2.9376	6 1/4
6 1/2	.5312	.6646	.798	1.062	1.328	1.594	1.859	1.992	2.124	2.39	2.656	3.186	6 1/2
6 3/4	.5744	.7182	.8610	1.1488	1.4366	1.7244	2.0122	2.1546	2.2982	2.5885	2.8788	3.4473	6 3/4
7	.6196	.7745	.9294	1.230	1.531	1.832	2.133	2.285	2.479	2.788	3.098	3.716	7
7 1/4	.6664	.833	.9996	1.328	1.639	1.950	2.261	2.409	2.603	2.908	3.213	3.9081	7 1/4
7 1/2	.7148	.896	1.078	1.402	1.726	2.050	2.374	2.527	2.721	3.036	3.351	4.074	7 1/2
8	.7648	.962	1.159	1.528	1.897	2.266	2.635	2.794	3.004	3.419	3.834	4.662	8
8 1/4	.816	1.028	1.239	1.618	1.997	2.376	2.755	2.919	3.134	3.549	3.964	4.802	8 1/4
8 1/2	.868	1.088	1.308	1.688	2.067	2.446	2.825	2.994	3.214	3.629	4.044	4.892	8 1/2
9	1.010	1.277	1.544	1.963	2.382	2.801	3.220	3.394	3.619	4.034	4.449	5.397	9
10	1.36	1.7	2.04	2.72	3.4	4.08	4.76	5.1	5.44	6.12	6.8	8.16	10
11	1.651	2.057	2.461	3.291	4.139	4.987	5.735	6.179	6.5823	7.464	8.2279	9.8735	11
12	1.9584	2.448	2.9376	3.9168	4.896	5.8752	6.8544	7.344	7.833	8.8128	9.792	11.7504	12
13	2.297	2.872	3.445	4.596	5.745	6.894	8.042	8.616	9.190	10.34	11.49	13.78	13
14	2.665	3.331	3.997	5.33	6.663	7.994	9.328	9.903	10.46	11.99	13.32	15.98	14
15	3.059	3.824	4.589	6.119	7.649	9.178	10.70	11.47	12.23	13.76	15.29	18.35	15
16	3.48	4.35	5.22	6.96	8.703	10.44	12.18	13.05	13.82	15.66	17.40	20.88	16
18	4.404	5.505	6.606	8.808	11.01	13.21	15.41	16.51	17.61	19.81	22.02	26.42	18
20	5.440	6.8	8.16	10.88	13.6	16.32	19.04	20.1	21.16	24.48	27.2	32.64	20

Power Required to Raise Water

Based on a Pump efficiency of 50 Per Cent

Lift in Feet	GALLONS PER MINUTE											
	1/2-H. P.	1-H. P.	3-H. P.	5-H. P.	7-H. P.	8-H. P.	10-H. P.	12-H. P.	15-H. P.	20-H. P.	25-H. P.	35-H. P.
10	100	200	600	1000	1400	1600	2000	2400	3000	4000	5000	7000
20	50	100	300	500	700	800	1000	1200	1500	2000	2500	3500
30	33	66	200	333	466	533	666	800	1000	1333	1666	2333
40	25	50	150	250	350	400	500	600	750	1000	1250	1750
50	20	40	120	200	280	320	400	480	600	800	1000	1400
60	16	33	100	166	233	266	333	400	500	666	825	1255
70	14	28	85	140	200	228	286	340	420	572	700	980
80	12	25	75	125	175	200	250	300	375	500	625	875
90	11	22	66	111	155	177	222	266	333	444	555	770
100	10	20	60	100	150	170	200	250	300	400	500	700
125	8	16	48	80	112	128	160	192	240	320	400	560
150	7	14	40	66	93	106	133	160	200	266	333	466
175	6	12	33	55	80	90	111	137	171	228	285	399
200	5	10	30	50	70	80	100	120	150	200	250	350
250	4	8	24	40	56	64	80	96	120	160	200	280
300	3	6	20	33	46	52	66	79	100	133	165	231
350	3	5	17	28	40	45	57	68	85	111	140	196



MECHANICAL IRRIGATION



Horse-Power of Shafts for Given Diameter and Speed

Diameter of Shaft Inches	REVOLUTIONS PER MINUTE								
	100	125	150	175	200	225	250	300	350
1 1/2	2.4	3	3.6	4.2	4.8	5.4	6	7.2	8.4
1 3/4	1.3	5.4	6.5	7.6	8.6	9.8	10.8	13.	15.2
1 1/2	6.5	8	9.7	11.2	13.	14.6	16.	19.4	22.4
1 3/4	10	12.5	15.	17.5	20.	22.5	25	30.	35.
2 1/4	14	17.8	21.	24.5	28	31.5	35.6	42.	49

Horse-Power Belting Will Transmit

Width of Belt Inches	H. P. PER 100 FEET BELT SPEED		Width of Belt, Inches	H. P. PER 100 FEET BELT SPEED		Width of Belt, Inches	H. P. PER 100 FEET BELT SPEED	
	Single Belt	Double Belt		Single Belt	Double Belt		Single Belt	Double Belt
1	.09	.18	9	.82	1.64	20	1.82	3.64
2	.18	.36	10	.91	1.82	22	2.00	4.00
3	.27	.55	11	1.00	2.00	24	2.18	4.36
4	.36	.73	12	1.09	2.18	28	2.55	5.09
5	.45	.91	14	1.27	2.55	32	2.91	5.82
6	.55	1.09	16	1.45	2.91	36	3.27	6.55
7	.64	1.27	18	1.64	3.27	40	3.64	7.27
8	.73	1.46						

Rules for Determining the Speed of Pulleys

1. To find the number of revolutions of the driven shaft when the diameter of the driving pulley and its speed are given, multiply the diameter of the driving pulley by its number of revolutions per minute, and divide the product by the diameter of the driven pulley; the quotient will be the speed of the driven pulley expressed in revolutions per minute.

Example: Driving pulley is 24 inches in diameter and makes 125 revolutions per minute. At what rate would a pulley eight inches in diameter be driven?

$$\frac{24 \times 125}{8} = 375 \text{ revolutions per minute.}$$

2. To find the diameter of the driven pulley when the diameter and number of revolutions of the driving pulley are given, multiply the diameter of the driving pulley by the number of its revolutions, and divide the product by the number of revolutions the driven pulley is to make.

Example: What would be the diameter of the driven pulley making 375 revolutions per minute, if the driving pulley is 24 inches in diameter and makes 125 revolutions per minute?

$$\frac{24 \times 125}{375} = 8 \text{ inches in diameter.}$$

3. To find the number of revolutions of the driving pulley when its diameter and the diameter and speed of the driven pulley are given, multiply the diameter of the driven pulley by its revolutions and divide the product by the diameter of the driving pulley; the quotient will be the speed of the driving pulley expressed in revolutions per minute.

Example:

$$\frac{8 \times 375}{24} = 125 \text{ revolutions per minute.}$$

4. To find the diameter of the driving pulley, multiply the diameter of the driven pulley by the number of its revolutions per minute, and divide the product by the number of revolutions of driving shaft; the quotient will be the diameter of the driving pulley required. Example:

$$\frac{8 \times 375}{125} = 24 \text{ inches in diameter.}$$

MECHANICAL IRRIGATION

Number of Acres Irrigated in Given Time

Gallons Pumped Per Minute	Acres Irrigated in 1 Hour						Acres Irrigated in 10 Hours						Acres Irrigated in 24 Hours					
	1 In. Deep	2 In. Deep	3 In. Deep	4 In. Deep	5 In. Deep	6 In. Deep	1 In. Deep	2 In. Deep	3 In. Deep	4 In. Deep	5 In. Deep	6 In. Deep	1 In. Deep	2 In. Deep	3 In. Deep	4 In. Deep	5 In. Deep	6 In. Deep
600	1.3	.6	.4	.3	.2	.2	13.2	6.6	4.4	3.3	2.6	2.2	31.8	15.9	10.6	7.9	6.3	5.3
824	1.8	.9	.6	.4	.3	.3	18.2	9.1	6.0	4.5	3.6	3.0	43.7	21.8	14.5	10.9	8.7	7.3
944	2.1	1.0	.7	.5	.4	.3	20.8	10.4	6.9	5.2	4.1	3.4	50.0	25.0	16.7	12.5	10.0	8.3
988	2.2	1.1	.7	.5	.4	.3	21.8	10.9	7.2	5.4	4.3	3.6	52.4	26.2	17.4	13.1	10.4	8.7
1000	2.2	1.1	.7	.5	.4	.3	22.1	11.0	7.3	5.5	4.4	3.7	53.0	26.5	17.6	13.2	10.6	8.8
1200	2.6	1.3	.9	.6	.5	.4	26.5	13.2	8.8	6.6	5.3	4.4	63.6	31.8	21.2	15.9	12.7	10.6
1500	3.3	1.6	1.1	.8	.6	.5	33.1	16.5	11.0	8.2	6.6	5.5	79.5	39.7	26.5	19.9	15.9	13.2
2000	4.4	2.2	1.4	1.1	.9	.7	44.2	22.1	14.7	11.0	8.8	7.3	106.0	53.0	35.3	26.5	21.2	17.6

Formulas

(Anderson)

To find the number of gallons in a tank, multiply the inside bottom diameter in inches by the inside top diameter in inches, then this product by 34, point off four figures, and the result will be the average number of gallons to one inch in depth of tank.

For the circumference of a circle, multiply the diameter by 3.1416.

For the diameter of a circle, multiply the circumference by .31831.

For the area of a circle, multiply the square of the diameter by .7854.

For the surface of a ball, multiply the cube of the diameter by 3.1416.

For cubic inches in a ball, multiply the cube of the diameter by .5236.

Short Formulas for Pump Capacity and Power

D. Diameter of Pump Cylinder in inches.

S. Length of stroke in inches.

N. Number of strokes per minute.

Q. Quantity of water in gallons, raised per minute.

H. Total height, in feet, water is elevated, figuring from surface of suction water to highest point of discharge.

Then we Have

$$D^2 \times .7854$$

—The area of a circle (or head of cylinder) of given diameter.

$$D^2 \times S \times .7854$$

—Capacity of pump in cubic inches, per stroke.

$$\frac{D^2 \times S}{294}$$

—Capacity of pump per stroke in gallons.

$$\frac{D^2 \times S}{2200.152}$$

—Capacity of pump per stroke in cubic feet.

$$\frac{D^2 \times S}{35.266}$$

—Capacity of pump per stroke in pounds of water.

$$D^2 \times S \times .7854 \times N$$

—Capacity of pump per minute in cubic inches.

$$\frac{D^2 \times S \times N}{294}$$

—Capacity of pump per minute in gallons (Q).

$$\frac{D^2 \times S \times N}{2200.152}$$

—Capacity of pump per minute in cubic feet.

$$D^2 \times H \times .3409$$

—Total pressure in pounds on the pump cylinder when at rest. When at work, add for pipe friction as determined from table elsewhere. (Table number.)

$$\frac{Q}{D^2 \times S \times .0034}$$

—Number of strokes per minute necessary to raise a given quantity of water in gallons.

The above formulas will give results correct to the third decimal place.



MECHANICAL IRRIGATION



An Irrigated Wheat Farm

Olustee, Oklahoma, November 11, 1912.

International Harvester Company of America,
Oklahoma City, Oklahoma.

Gentlemen:—

Replying to your favor of recent date as to how we are getting along irrigating, beg to say that each day I become more enthused in the work, as all do when started right. It is one continuous round of pleasure to see those engines working, and the pumps pouring forth the great floods of water.

Since installing the 20-horse power engine and pump on my farm, one mile north of Olustee, we



Flume on the Hix farm



IHC 25-H. P. and 35-H. P. pumping plants on the Hix farm

have put under irrigation over 1,000 acres of land, using nine International engines and pumps ranging from 15-horse power to 35-horse power, double cylinder, and I am pleased to say that up to date,

we have had no trouble nor expense whatever; we know each day just what they will do, and can plan our work weeks ahead and not be disappointed by the engines and pumps not working. We have no expert engineer, the farm hands do the starting and stopping—the engines and pumps do the rest. The sweet-potato harvest is now on in full blast in the irrigated district here. The yield reported from the different farms ranges from 250 to 400 bushels per acre. The last cutting of alfalfa was finished the first of the month.

Your personal kindness in all our transactions has been highly appreciated, and I take this opportunity to thank you.

Yours very truly,

(Signed) H. L. Hix.



The result of irrigating with an I H C engine. Wheat field on farm of H. L. Hix, Olustee, Oklahoma. This wheat sowed in December, 1910, yielded from 25 to 30 bushels per acre, notwithstanding the fact that there had been no rain since the summer of 1910—the only wheat to be cut anywhere in this locality in 1911

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